HIGH SCHOOL AND UNIVERSITY MATRICULATION EXAMINATIONS BOARD

DEPARTMENTAL EXAMINATIONS, 1942

PHYSICS 2

Time—3 hours.

Note—**This paper is in two sections, A and B. The questions in Section A are of the objective type and are to be answered by a single word, phrase, number or letter placed in the space provided. Instructions are given for each type of question.**

All questions are to be answered in this booklet in the spaces provided.

Pages 6, 8, 10, 12, 14, 16 and 18 are left blank for rough work and calculations.

SECTION A

Questions 1 to 21 are to be answered by writing in the space provided the word, phrase or number, which will accurately complete the statement. You will receive TWO MARKS for each correct answer.

1. If the temperature of any gas could be reduced to absolute zero, its pressure in centimetres of mercury would be..............................

2. The Centigrade temperature at which a gram of water occupies the least volume is ....

3. On a winter day a Fahrenheit thermometer read zero. At the same time and place, a Centigrade thermometer would have read ....

4. At 15°C., the pressure exerted by a gas confined in a tank is 76 cm. of mercury. The pressure in centimetres of mercury exerted by this gas, when its temperature is raised to 50°C., is ....

5. Fifteen calories of heat are given to one gram of water. The increase in the temperature of the water in Centigrade degrees is ....

6. It requires 0.113 calories of heat to change 1 gram of iron through 1 Centigrade degree. The number of B. T. U.'s of heat required to change 1 pound of iron through 1 Fahrenheit degree is..............................
(1 lb. = 454 grams)

7. When 50 grams of water at 32°F. are frozen, the number of calories of heat given off by the water is ....

8. Paraffin melts at about 52.4°C. 3,590 calories of heat are required to change 100 grams of paraffin from the solid form to the liquid form at the same temperature. The numerical value of the heat of fusion of paraffin is..............................

....

9. When a room is heated by an open fireplace, heat is transferred from the fire to the room principally by the process of

....

10. When a piece of soft iron is brought near the North pole of a strong bar magnet, the piece of soft iron is found to have poles developed in it. This process, by which the soft iron is magnetized, is called

....

11. Two metal plates separated by a sheet of glass may be used to store electric charges. Such a device is called an electric

....

12. The name of the smallest charge of negative electricity is

....

13. A student, in charging an uncharged electroscope, rubbed a glass rod briskly with a piece of silk and touched the glass rod to the knob of the electroscope. The sign of the charge then on the electroscope was

....

14. Electric charges, moving through a conductor in the same direction, constitute

an electric ....

15. A magnetic compass is held just under a wire whose direction is parallel to the needle of the compass. A strong steady electric current is sent through the wire. The North end of the needle is then deflected toward the West. The direction of the current is from

.... to ....

16. An electric lamp requires 0.4 ampere of current from a 110-volt line. The number of watts used in the lamp under these conditions is

....

17. Six 180-ohm lamps are connected in parellel across a line. The combined

resistance of these lamps, in ohms, is..

18. The name given to the type of electric current obtained from a storage battery

is ....

19. The type of electric current delivered to a power line by a dynamo with a

commutator is ....

20. The type of electric current delivered to a power line by a dynamo with slip

rings is ....

21. The number of cycles per second in the current from a two-pole alternator, whose speed is 1,800 revolutions per minute is

....

In Questions 22 to 35, name the device that best performs the operations stated. You will receive ONE MARK for each correct answer.

22. Measures the temperature of the air. ....

23. Controls the temperature of air in buildings. ....

24. Keeps perishable food from spoiling. ....

25. Converts the energy of heat into mechanical motion. ....

26. Changes the voltage of an alternating current. ....

27. Secures the proper mixture of gasoline vapor and air in a gasoline engine. ....

28. Determines the altitude of an airplane. ....

29. Detects a feeble electric current. ....

30. Determines directly the specific gravity of a liquid. ....

31. Produces an E. M. F. by chemical action. ....

32. Measures the strength of an electric current. ....

33. Converts mechanical energy into electrical energy. ....

34. Detects a charge of electricity on a body. ....

35. Measures the humidity of the air. ....

Each of the following questions, 36 to 54, consists of an incomplete statement followed by a number of completions. Select the one correct completion and write its number in the brackets at the right. You will receive TWO MARKS for each correct answer.

36. An alternating current cannot be used to —

(1) charge a storage battery.
(2) light lamps.
(3) run a motor.
(4) ring a door bell.
(5) heat a toaster. (..................)

37. Assuming no change in the absolute moisture content of the air that passes from out-of-doors, where the temperature is 80°F., to a room where the temperature is 70°F., the relative humidity is —

(1) higher inside the room than outside.
(2) higher outside the room than inside.
(3) the same in both places. (..................)

38. A 100-foot steel measuring tape, correct at 32°F., is used to measure a javelin throw on a day when the temperature is 90°F. If the tape reads 180 feet 9½ inches for a throw, the correct distance for the throw is —

(1) greater than this.
(2) less than this.
(3) exactly the same. (..................)

39. In a reading lamp, an 80-candle-power light was used to replace one of 20 candle-power. To obtain the same illumination as before, a reader originally 1 foot from the lamp must move to a distance from the lamp of —
(1) 4 feet
(2) 3 feet
(3) 2 feet
(4) ½ foot
(5) ¼ foot (..................)

40. Any two bodies with equal masses are necessarily at the same temperature if —

(1) they contain equal amounts of heat.
(2) they radiate energy at equal rates.
(3) neither gains heat from the other when they are placed in contact.
(4) their molecules have equal mean speeds.
(5) they are heated the same length of time in an oven. (..................)

41. Radiation is the only possible means of transfer of energy in —

(1) matter whose molecules are not completely free to move.
(2) gases and liquids.
(3) regions where matter is absent.
(4) hot water heating systems.
(5) cases where very high temperatures are involved. (..................)

42. A primary circuit consists of a battery of cells sending a current through a resistance and an electromagnet. The secondary circuit consists of a coil of wire of many turns connected to a galvanometer. The electromagnet is placed inside the secondary coil. No current flows in the secondary coil —

(1) when the electromagnet is moved in the secondary coil.
(2) when the resistance in the primary circuit is decreased.
(3) when the resistance in the primary circuit is increased.
(4) at the breaking of the primary circuit.
(5) when there is no relative change in the position of the electromagnet and the secondary coil, and the current in the primary circuit does not change. (..................)

43. The power of a machine may be calculated from a knowledge of the —

(1) mechanical advantage of the machine used.
(2) magnitude of the output force.
(3) magnitude of the output force and the time involved.
(4) energy delivered.
(5) energy delivered and the time involved. (..................)

44. Three 100-gram metal balls, A, B and C, of specific heats 0.22, 0.11 and 0.055 respectively, are heated to 100°C. in boiling water and then placed in three similar calorimeters containing equal masses of water at 10°C. The drop in temperatures in the metal balls will be —

(1) greatest in A.
(2) greatest in B.
(3) greatest in C.
(4) the same for all. (..................)

45. A piece of aluminium is floating in a bottle half full of mercury. When water is poured in to fill the bottle, the piece of aluminium —

(1) rises a little farther out of the mercury.
(2) sinks a little farther into the mercury.
(3) remains at the same level.
(4) sinks to the bottom.
(5) rises to the top. (..................)

46. Four copper wires of exactly the same dimensions have, when connected in parallel, the same resistance as one copper wire of the same length but with a diameter —

(1) $\sqrt{2}$ times as large.
(2) 4 times as large.
(3) $\frac{1}{2}$ as large.
(4) $\frac{1}{4}$ as large.
(5) twice as large. (..................)

47. When the distance between the metal plates of an electric condenser is increased, the capacity of that condenser is —

(1) increased.
(2) decreased.
(3) unchanged. (..................)

48. An electroscope is charged positively. A piece of material, which is thought to be charged, is brought near the knob of the electroscope and the leaves are observed to fall together somewhat. This shows that —

(1) the material is charged positively.
(2) the material is charged negatively.
(3) the material is uncharged.
(4) we do not have enough information to tell whether the material is charged or not. (........................)

49. A hard rubber rod is charged by friction and is then suspended by means of a thread and a wire stirrup, in such a way that the rod is horizontal and free to turn in a horizontal plane. This rod will then come to rest —

(1) always in a North and South direction.
(2) always in an East and West direction.
(3) always in some definite intermediate direction.
(4) in any direction where the rod happens to stop swinging. (........................)

50. The filament of an electric light is made of tungsten. As the filament gets hot after turning on the current, the resistance of the filament —

(1) increases.
(2) decreases.
(3) is not changed. (........................)

51. Two resistance coils have a combined resistance of 50 ohms when connected in series, and of 12 ohms when connected in parallel. One of the coils must have resistance, in ohms —

(1) of less than 12.
(2) the same as the other.
(3) of 20.
(4) of 40.
(5) of more than 50. (........................)

52. A shunt-wound electric motor, with an armature resistance of 0.2 ohm, is running on a 120-volt circuit. The armature current —

(1) can be computed from the given data.
(2) is the same as the field current.
(3) depends upon the armature speed.
(4) is proportional to the counter E. M. F.
(5) is independent of the line voltage. (........................)

53. If a negatively charged rod is brought near the knob of an uncharged electroscope, the leaves of the electroscope —

(1) do not change.
(2) spread apart.
(3) come together.
(4) spread slightly and then come together.
(5) come together slightly and then spread apart. (........................)

54. If the boiling point of a liquid at a certain place is always higher than at sea level —

(1) the place is above sea level.
(2) the place is below sea level.
(3) the place is practically at sea level.
(4) the air in the place is usually saturated. (........................)

TURN TO PAGE 7 FOR SECTION B.

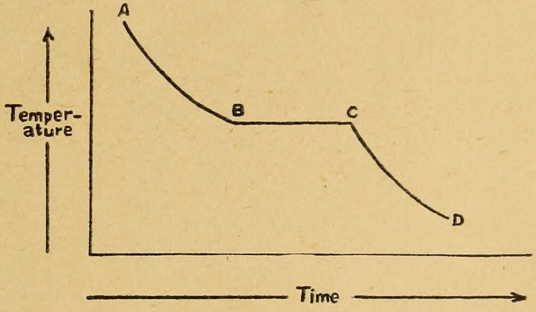
FOR ROUGH WORK

SECTION B

Answer the following questions or problems in the spaces provided. All rough work should be done on the adjacent page. Numerical calculations should be completed.

Values

4 **55.**



The above graph represents the temperature of a certain liquid during the process of cooling. Substitute appropriate letters from the graph in the blank spaces below:

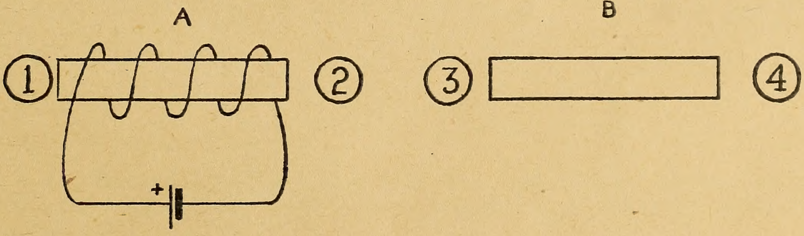
(1) This substance was entirely liquid from ....to..............................

(2) It was in the process of solidifying from ....to..............................

(3) It was entirely solid from ....to..............................

(4) The amount of heat lost from ....to.............................. divided by the mass of the substance is the heat of fusion.

2 **56.**



If an electric current is passed through the coil as indicated in the above diagram —

(1) which end of the soft iron bar A becomes an N-pole?..............................

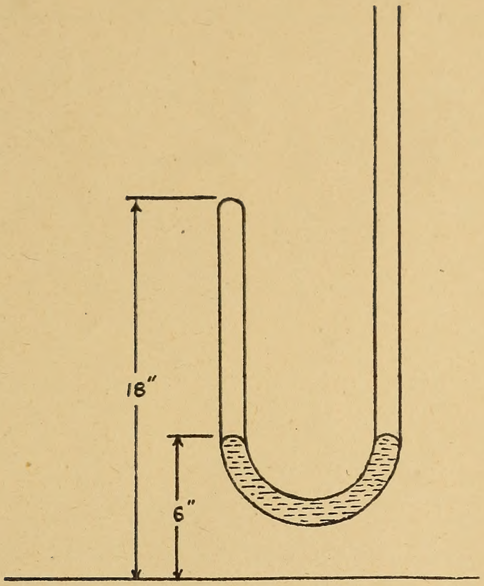
(2) which end of the soft iron bar B becomes an N-pole?..............................

TURN TO PAGE 9 FOR QUESTION NO. 57.

FOR ROUGH WORK

Values

5 **57.**



Atmospheric pressure is 30 inches of mercury.
Dry air is trapped in the J-tube shown above in such manner that the mercury in each arm stands six inches above the top of the table. Mercury is now poured into the open end of the tube until the surface of the mercury in the closed arm is eight inches above the table top. The distance from the table to the top of the mercury in the open arm will now be

(..............................inches)

4 **58.** A 6-volt storage battery is charged at the rate of two amperes when connected to a 6.1-volt direct current source. The internal resistance of the battery is

(..............................ohms)

3 **59.** If a rod, which is 100 centimetres long at 0°C., has a length of 100.11 centimetres at 100°C., its coefficient of linear expansion is

..............................per °C.

TURN TO PAGE 11 FOR QUESTION NO. 60.

FOR ROUGH WORK

Values

5 **60.** Twelve grams of a metal, whose electrochemical equivalent is 0.002 gram per coulomb, is deposited in 20 minutes by a current of

....amperes.

5 **61.** A metal ball of specific heat 0.1 falls to the ground from a certain height and its temperature is observed to rise 1°F. If it is assumed that all the energy of fall goes into heating the ball, this height would have to be

(778 foot-pounds = 1 B.T.U.)

....feet

TURN TO PAGE 13 FOR QUESTION NO. 62.

FOR ROUGH WORK

Values

62. 200 grams of a liquid of specific heat 0.5 are contained in a calorimeter (water equivalent 10.5 grams) at a temperature of 42°C. 10 grams of ice at 0°C. are allowed to melt in the liquid and then 4 grams of steam at 100°C. are condensed in the mixture. What is the temperature —

5 (1) after the ice has melted? ....

5 (2) when the steam has condensed? ....

3 **63.** (1) If an electric light bulb uses 30 watts when operating normally under a potential difference of 120 volts, what is its resistance?

2 (2) The same bulb is then connected to a dry cell furnishing 1.2 volts, and a current of only 0.02 ampere passes through it. What is its resistance now?

5 (3) If the resistance of the tungsten filament in the light is proportional to its absolute temperature, what is the temperature of the filament under normal operation, if its temperature when used with the dry cell is taken to be 27°C.?

TURN TO PAGE 15 FOR QUESTION NO. 64.

FOR ROUGH WORK

Values

5 **64.** 5,000 cubic metres of hydrogen at 2°C. and at a pressure of 770 millimetres of mercury is used to fill a balloon, which may be regarded as capable of perfectly free expansion. What is the volume of the gas bag after it has risen to a point where the pressure is 100 millimetres and the temperature — 48°C.?

6 **65.** You are asked to devise an experimental method for determining the coefficient of expansion of a non-volatile oil. Describe, by aid of a diagram, the set-up of apparatus you would choose for the purpose. State what measurements you would make, and explain how your data would be used to calculate the coefficient.

TURN TO PAGE 17.

FOR ROUGH WORK

Values

66. A coil of resistance 20 ohms is connected in series with two wires which are in parallel. The resistance of one of these wires is 6 ohms and of the other 3 ohms. The circuit is completed by attaching this combination of resistance to a 110-volt line.

4 (1) What is the drop in potential (*a*) across the 20-ohm coil?

1 (*b*) across the 6-ohm wire?

2 (2) What is the current through the 3-ohm wire?

3 (3) How many calories per second are liberated in the 20-ohm coil?

TURN TO PAGE 19 FOR QUESTION NO. 67.

FOR ROUGH WORK

Values

8 **67.** Describe, by aid of a diagram, the construction of a simple type of electric motor. Explain the principle of its operation. What is meant by the back electromotive force of a motor? Under what circumstances is it (1) greatest? (2) least? What is its effect upon the operation of the motor?

FOR FINISHED WORK

TURN TO PAGE 20

Values

FOR FINISHED WORK

6 **68.** A motor, using a current of 2 amperes at 120 volts, lifts a weight of 22 pounds to a height of 150 feet in half a minute. Find the efficiency. (746 watts = 1 horsepower)